NRDC
THE EARTH'S BEST DEFENSE

NATURAL RESOURCES DEFENSE COUNCIL

November 10, 2003

The Honorable Edward J. Markey
U.S. House of Representatives
Washington, D.C. 20515

Dear Congressman Markey:

I am writing in regard to errors in: (a) the October 16, 2003, testimony of Mr. Robert Bonner, Commissioner, Bureau of Customs and Border Protection, Department of Homeland Security to the Infrastructure and Border Security Subcommittee of the House Select Committee on Homeland Security; and (b) the September 24, 2003, letter to you from Pamela J. Turner, Assistant Secretary for Legislative Affairs, Department of Homeland Security, both addressing the Bureau of Customs failure to detect the smuggling of depleted uranium ("DU")—and by inference, highly-enriched uranium, or "HEU"—into the United States by an ABC News Investigative Unit.

In his colloquy with you at the October 16 hearings, Mr. Bonner claimed, "I don't think it [the ABC smuggling test] was a valid test with respect to the capabilities of detecting let's say a terrorist weapon." To support this claim, Mr. Bonner made several statements to the subcommittee that are factually incorrect and, in important respects, misleading in their implications for sound policy-making.

a) Mr. Bonner claimed that depleted uranium is "a very low emitting substance . . . It actually emits about as much radiation as a pile of dirt."

Response:

While this statement correctly implies that DU has low specific activity compared to many other radioactive materials, in reality *DU is about 35,000 to 100,000 times more radioactive than dirt*. The specific activity (i.e., radioactive disintegrations per second per gram of material) of DU is on the order of 15 to 40 thousand Becquerel per gram (Bq/g) depending on the isotopic mixture, where one a Becquerel is defined as one disintegration per second. The average concentration of radioactivity in soil (from potassium-40, uranium-238 and thorium-232) is about 0.42 Bq/g. In other words, Mr. Bonner has understated the radioactivity of DU by five orders of magnitude.

Similarly, the average dose to an individual from radioactivity in soil is about 0.005 mrad/hour [A *rad* is a commonly used unit of absorbed radiation dose. One *rad* is equal to an absorbed dose of 100 ergs/gram, or 0.01 joules/kilogram, where ergs and joules are units of energy], while the radiation dose at the surface of an unshielded slug of DU (mostly due to beta radiation) is about 240 mrad per hour—once again almost five orders of magnitude greater than "dirt".

b) **Mr. Bonner stated, "... highly enriched uranium that's not lead shielded emits significantly more gamma rays than depleted uranium. So it's easier to read with a radiation detection device from greater distance."**

Response:
While it is undisputed that *unshielded* HEU emits substantially more gamma radiation than DU, and would therefore be easier to detect, that is not the issue. The correct and relevant comparison is the radiation that escapes through the container used in the ABC smuggling test. The lower energy X-rays and gamma rays from DU and HEU are readily absorbed by the approximately 3.175 millimeters (mm) (one-eight inch) of lead shielding plus the wall of the steel pipe containing the uranium and lead shielding. For gamma-ray energies above about 225 keV, the rate of gamma emissions from DU actually *exceeds* that from HEU. As can be seen from Figure 2 of the attachment, the gamma-ray count rate measured by a radiation survey meter, located more than a meter away from the *shielded* container used in the ABC smuggling test, would be more than ten times *lower* if the HEU were substituted for the DU. Thus, the DU would have been more likely detected.

c) **Mr. Bonner stated, "... there is a certain quantity [of highly enriched uranium] that would displace a certain amount of space, and if you're going to prevent it from emitting [significant radiation] you have to have some significant lead shielding of the material. ... I have a great deal of confidence that that kind of anomaly would have been detected by the x-ray scan that was done on the container."**

Response:
The mass of the DU used in the ABC experiment was approximately 15 pounds, or about 6.8 kilograms. With the same mass of weapon-grade HEU, the U.S. nuclear weapons labs could construct a pure fission implosion weapon having a yield in the range of 1-5 kilotons of TNT equivalent. This is within the technical capability of the weapon labs of at least five other nuclear powers, but not within the capability of a terrorist group, which would be more likely to pursue a simpler "gun-type" design that relies on assembling a supercritical mass of HEU metal at normal density.

The amount of HEU used in the *Little Boy*, the gun-assembly type fission weapon dropped on Hiroshima, was just under 10 times the mass of DU in the ABC smuggling test. *Little Boy* had a yield of 15 kilotons of TNT equivalent. A credible terrorist weapon with a yield of a few hundred tons of TNT equivalent could be fabricated with substantially less HEU—perhaps one-half the amount that was used in the *Little Boy* device. Therefore, it is reasonable to assume that terrorists in pursuit of a gun-type weapon would have to smuggle an amount of HEU several times that of the DU used in the ABC smuggling test. However, Mr. Bonner apparently is unaware that the HEU in the *Little Boy* device was comprised of 16 *separate* HEU components, most of which had a mass *less* than that of the DU used in the ABC test. In fact, none of the HEU components would need to weigh more than 15 pounds (6.8 kg). *Little Boy* could just as readily be made with 16 components weighing 4 kg each, or 32 components weighing 2 kg each, or even 64 components weighing one kilogram each. Each of these small components easily could be shielded with a few millimeters of lead shielding and hidden throughout one or dozens of cargo containers. Moreover, these individual components could be rotated to leave only pencil-thin images when the cargo container is X-ray scanned from the side. Carefully placed in machinery or plumbing supplies, they would be far more difficult to detect by X-ray scans than the rather unsophisticated-shaped container used by the ABC News Investigative Unit.

In the September 24, 2003, letter to you from Assistant Secretary Pamela Turner, the Department of Homeland Security ("DHS") notes that the container was flagged and screened by Customs and Border Protection ("CBP") at the Port of Long Beach. The container was examined by a large-scale gamma-ray imaging system that produces an X-ray type image, and officers preparing the container for X-ray examination carried personnel radiation detectors. The X-ray imaging and agents carrying personal radiation detectors did *not* detect the presence of the DU.

The conclusion of our detailed technical analysis is that if Customs did not detect the DU, they would not have detected a comparable quantity of HEU. The basis for this claim is summarized in "The ABC News Nuclear Smuggling Experiment: The Sequel" on NRDC's web site at http://www.nrdc.org/nuclear/furanium.asp. More precise calculations are provided in the attachment to this letter.

In Assistant Secretary Turner's letter to you:

d) **DHS claims that NRDC's analysis is "not accurate because it presumes that detection and interdiction of nuclear materials are based on surface dose rates rather than characteristic gamma emissions and contaminant signatures."**

Response:
Our analysis did not presume the use of a gamma-ray spectrometer to detect "characteristic gamma emissions" because: first, as DHS admits, the customs agents wore personal dosimeters and *did not use any gamma-ray spectrometers* to survey the cargo containers at Long Beach or Staten Island in the prior test in 2002; and second, even if CPB personnel had used the more costly gamma-ray spectrometers, they still would have failed to detect the DU (or HEU). As seen from Figure 2 (attached), had HEU been in the container used by ABC News, the dose rate two meter away would have been almost two orders of magnitude below background levels. The intensity of the characteristic gamma-ray emissions at this distance would have been too weak to permit identification (above the background of Bremsstrahlung radiation and photons from Compton scattering of gamma-rays).

e) **DHS claims, "All factors considered, uranium-235 is more easily detected than uranium-238—even though highly enriched uranium is easier to shield from detection."**

Response:
This is simply a false statement with respect to the relevant case—that is the detection of shielded uranium using passive radiation detectors such as simple radiation survey meters or gamma-ray spectrometers. As little as one millimeter of lead shielding reduces the dose rate from an HEU source to less than that from a comparable mass of DU.

f) **DHS claims, "With increased shielding, the probability increases that the shielding will be detected using a VACIS [Vehicle and Cargo Inspection System] examination of the cargo."**

Response:
DHS apparently does not realize how little shielding is required to reduce the rate of photon emissions from HEU to a rate below that of DU of equal size. As can be seen in Figure 1 (attached), it requires less than a millimeter of lead to reduce the rate. The one-eighth inch (3.175 mm) of lead shielding used in the container smuggled by ABC News was more than enough to reduce the dose rate from a HEU cylinder to a rate lower than that from a DU cylinder of the same shape. The steel container containing the DU and lead shielding could have even accommodated an additional 4-5 mm of lead shielding. So if HEU were substituted for DU, the HEU would have a lower rate of photons emitted from the container. In other words, with HEU there would have been no higher probability of detection using the VACIS X-ray scanner.

To summarize, DHS is wrong to assert that it is more difficult to smuggle HEU with the VACIS X-ray scanner and the current array of passive radiation detectors used by Customs. *DHS is either misinformed, or deliberately misleading the Congress on a matter of supreme importance to national security.*

The casualties from a one-kiloton nuclear explosion at ground level at the foot of Brooklyn Bridge under average September wind conditions would be comparable to the casualties at Hiroshima. The consequences of the lower explosive yield being offset by the added fallout from a ground burst and the higher population density of New York. The economic loss to the United States from such an event would approach, if not exceed, a trillion dollars. This issue is surely of sufficient importance that DHS should gets its facts right. Commissioner Bonner, and DHS Under Secretary Asa Hutchinson, who made similar remarks in a television interview last year following the ABC smuggling of DU from Istanbul through Staten Island, are badly misinformed and are being poorly served by the DHS technical staff. If Commissioner Bonner and Under Secretary Hutchinson continue to question the NRDC analysis, I suggest that you task one of the nuclear weapon laboratories to assess which analysis of this issue is correct. In the interest of national and international security, these discrepancies must be addressed so that policymakers can be properly informed. DHS must either withdraw its erroneous testimony and promptly correct the record, or provide a detailed technical rebuttal disproving the NRDC data and analysis of the HEU detection problem.

There is no shame in admitting that the probability of detecting HEU being smuggled into the United States—by terrorists with the know how to construct a crude nuclear explosive device—is exceedingly low. The physics is against us, and pretending otherwise can only lead to an unproductive and potentially disastrous misallocation of resources. We could spend billions of dollars searching for the equivalent of a needle in a haystack. The greatest leverage for addressing this issue is oversees at the points of production, use and storage of this dangerous material, not at the borders. I find it deeply disturbing that the Administration has not significantly increased the priority of the several existing government programs designed to reduce the availability of HEU and improve its physical security. And I find it equally disturbing that some in the Congress have proposed to relax policies in place that are designed to discourage commercial use of HEU in research and test reactors.

If I can be of further assistance, please do not hesitate to contact me.

Sincerely,

Dr. Thomas B. Cochran
Senior Scientist and Director, Nuclear Program
Wade Greene Chair for Nuclear Policy
Natural Resources Defense Council

Attachment: "A Comparison of the Radiation Dose Rate
From Depleted and Highly Enriched Uranium"

cc. Congressman Christopher Shays
Co-chair, House Bipartisan Task Force on Non-Proliferation

Mr. Asa Hutchinson
Under Secretary, Department of Homeland Security

Mr. Robert Bonner
Commissioner, Bureau of Customs and Border Protection,
Department of Homeland Security

A Comparison of the Radiation Dose Rate From Depleted and Highly Enriched Uranium

Thomas B. Cochran
Natural Resources Defense Council

November 10, 2003

To compare the radiation dose rate from depleted and highly enriched uranium a series of calculations were performed using MCMP4C2, a Monte Carlo N-particle transport code. This code was developed by the Los Alamos National Laboratory and is maintained by the Oak Ridge National Laboratory ("ORNL") as part of Computer Code Collection of ORNL's Radiation Safety Information Computational Center (RSICC).

The characteristics of the depleted and highly enriched uranium sources were:

	DU	HEU
U mass (kg)	6.76442	6.68389
U density (g/cm^3):	18.9513	18.7255
U cylinder length (cm)	10.2709	10.2709
U cylinder diameter (cm)	3.175	3.175
Uranium aged (years)	10	10
U-238		
wt. %	99.80112	5.8
atom %	99.79857	5.73077
U-235		
wt. %	0.198	93.5
atom %	0.200053	93.56574
U-234		
wt. %	0.00088463	0.7
atom %	0.0009	0.70349

Discrete gamma-ray energies and associated photon intensities for U-238, U-235 and U-234 and Bremsstrahlung energy bins and associated intensities for U-238 were calculated using Lawrence Livermore National Laboratory's GAMGEN code. The uranium isotopes were aged for 10 years to allow for the buildup of radioactive daughter products. Photon energy and intensity data for photon energies >90keV were used as input data for the MCNP4C2 calculations. These data included 563 discrete lines and 94 Bremsstrahlung bins for U-238 and its daughters, 440 discrete lines for U-235 and its daughters, and 257 discrete lines for U-234 and its daughters. Twenty million Monte Carlo histories were performed in each calculation. The energy deposited in a "ring detector" of air, 4 cm wide, 0.4 cm thick, and centered perpendicular to the central axis of the uranium cylinder, was calculated using the code's "Tally 6" to specify the desired output. This code output, in MeV/g per history, was then converted to units of dads/hr.

Two sets of calculation results are reported below, in Figures 1 and 2, respectively. In the first set the DU and HEU cylinders were each assumed to be shielded with lead (density 11.35 g/cm^3), and the "ring detector" was fixed at 5 cm from the axis of the uranium cylinder, or 1.825 cm from the surface of the cylinder. In this series of calculations the thickness of the lead shielding was varied from 0 to 10 millimeters (mm), These results are reported in Figure 1.

In the second set of calculation, the shielding used in the ABC smuggle test was held fixed. Here the uranium cylinder was enclosed in 0.02 cm of aluminum (the thickness of two soda cans), which in turn was surrounded by 0.3175 cm of lead. Additional shielding was provided by a steel pipe (and end caps), which contained the lead (and aluminum) shielded uranium source. The 18.8913 cm-long steel pipe was 0.5486 cm thick with an outside radius of 4.5276 cm. Dose rates were calculated as a function of the distance from the uranium cylinder axis to the "ring detector." This distance to the "ring detector" was varied from 5 to 200 cm and the results are reported in Figure 2.

As seen from Figure 1, with a millimeter or more of lead shielding, the dose rate from the shielded DU source exceeds that from a comparable HEU source. As seen form Figure 2, the dose rate from the shielded DU source used in the ABC tests is almost an order of magnitude greater than that from a similar sized HEU source. At two meters distant dose rate from a DU source is almost an order of magnitude below background, and almost two orders of magnitude below background for the HEU source.

In these calculations Bremsstrahlung radiation from daughters of U-235 and U-234 were unavailable and therefore not included. These Bremsstrahlung contributions would increase the HEU dose rate results, but not significantly. Also, increasing the age of the uranium would increase both the DU and HEU dose rate results, but not significantly. The U-234 concentrations in DU and HEU are estimates. The actual concentration of U-234 in the DU used by ABC News is not known.

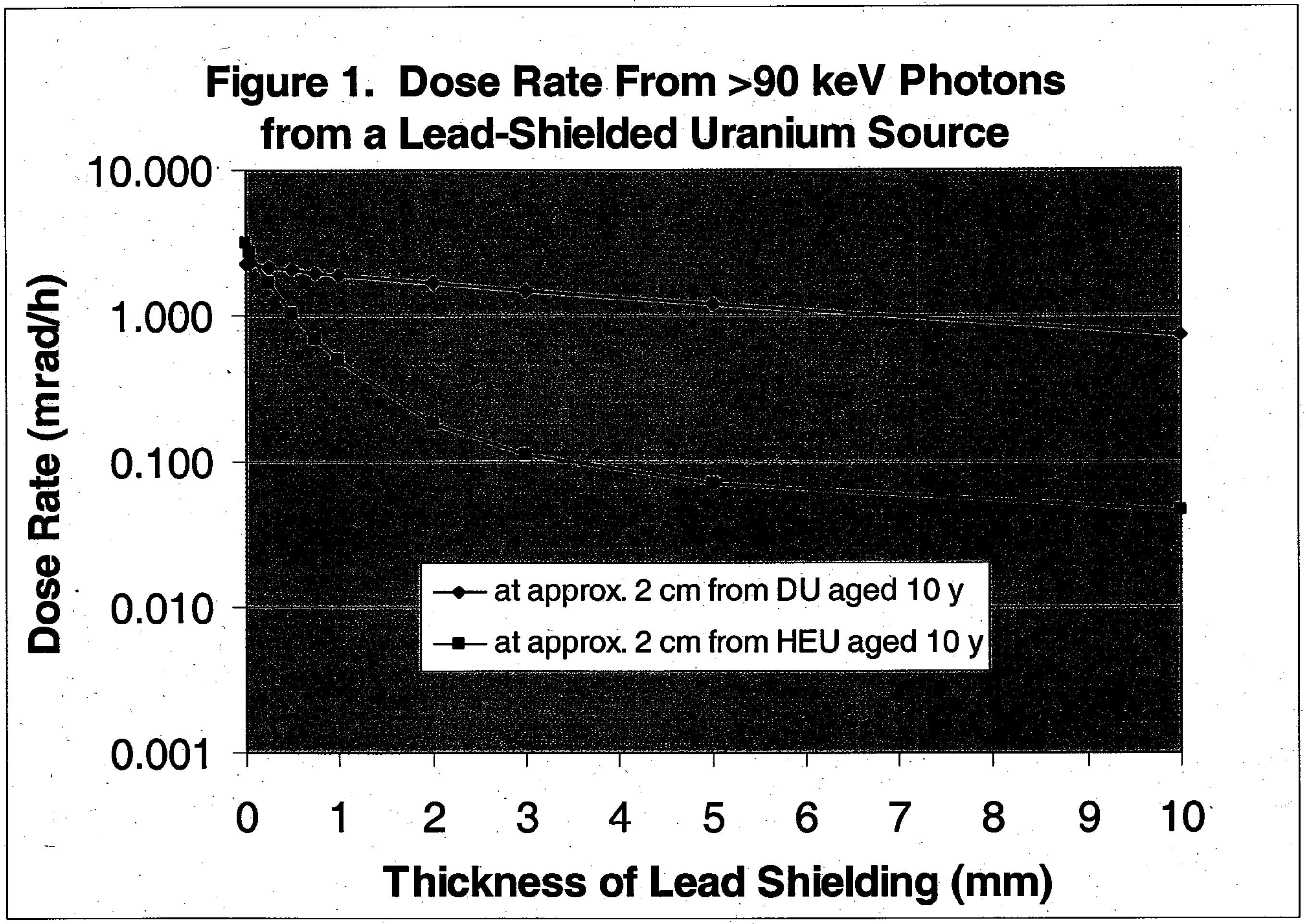
Figure 1. Dose Rate From >90 keV Photons
from a Lead-Shielded Uranium Source
10.000
1.000
0.100
0.010
0.001
Dose Rate (mrad/h)
at approx. 2 cm from DU aged 10 y
at approx. 2 cm from HEU aged 10 y
0
1
2
3
4
5
6
7
8
9
10
Thickness of Lead Shielding (mm)

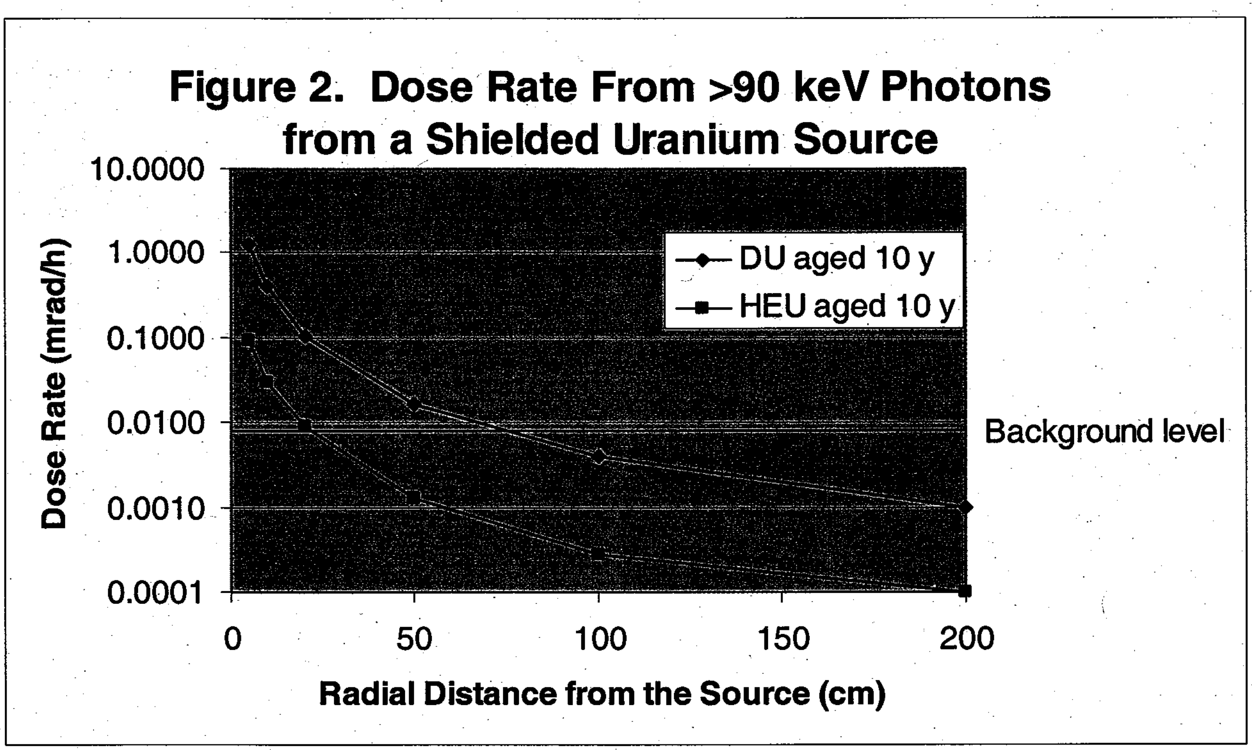
Figure 2. Dose Rate From >90 keV Photons
from a Shielded Uranium Source
10.0000
1.0000
0.1000
0.0100
0.0010
0.0001
Dose Rate (mrad/h)
DU aged 10 y
HEU aged 10 y
Background level
0
50
100
150
200
Radial Distance from the Source (cm)